A Time to Reflect
before we launch forward

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Reflection, or consciously thinking about our experiences, is the key to powerful learning. Reflection allows us to analyse our experiences, make informed changes based on our mistakes, maintain successful practices, and build upon or modify our past understandings based on new and emerging knowledge. This paper describes my journey through education in Victoria and provides insights into the elements I have identified as integral to successful mathematics education as we launch into the future.

Introduction

As teachers we are more than just educators, we also become the best 'thieves', 'samplers' and 'borrowers'. Much of our growth stems from looking at an idea, resource and activity then using our professional judgement and knowledge to adapt it to suit the students in our class, the school we are working in or for the professional learning of teachers. We grow from this culture of sharing: the sharing of ideas, research and enthusiasm for our endeavour to provide our students and teachers with the best of mathematics education.

I have been extremely fortunate over my teaching career to have participated in some valuable numeracy projects and had the privilege of working and learning from a community of 'dedicated sharers'.

In this paper I will discuss the projects and programs that have most strongly influenced the way in which I communicate mathematics: the *Teaching and Learning Coaching Initiative*, implementing structured problem-solving mathematics lessons through Japanese Lesson Study and specific programs including *YuMi Deadly Maths* and *Back to Front Maths (Problem-based Maths)*.

Teaching and Learning Coaching Initiative

In 2007, the Department of Education and Early Childhood Development (DEECD) worked extensively with Professor Richard Elmore on evaluating the school improvement practices in Victorian Government schools. Elmore (2007) noted that human investment was the key strength of the education system in Victoria and suggested that teachers should view their teaching practice as one in which new and powerful ideas are public goods, rather than private practice. Teachers should be exposed to coaching and mentoring others as early as possible in their careers.

In 2009 I was one of 200 teaching and learning coaches seconded to the *Teaching and Learning Coaches Initiative* and I commenced working in the Western Metropolitan Region as part of the school improvement team. The initiative was underpinned by the key understanding that student achievement is determined to a significant extent by the knowledge and skills of teachers in individual classrooms.

The aims of the initiative were to improve:

- student learning outcomes, especially in the areas of literacy, mathematics and/or science, for students in identified schools;
- teacher knowledge and skills related to effective literacy, mathematics and science teaching; and
- teacher capacity in the use of ICT, particularly for online curriculum planning, assessment and delivery in preparation for the ultranet school capacity to support improved student learning outcomes (DEECD, 2013).

The purpose and intention was to provide intensive assistance to identified schools to bring about changes in classroom practices necessary to improve student outcomes and build teacher capacity. Six key elements emerged as the ongoing focus for the coaches. The elements were:

- building professional relationships within the schools;
- building teacher capacity to establish priorities, analyse student results, measure student progress and use collected data purposefully;
- improving the quality of learning and teaching through purposeful instruction by modelling, observing and providing feedback;
- providing substantive conversations with teachers to elicit goals, prompt inquiry and support reflective practice;
- developing school improvement by working with the school leadership team and professional learning teams; and
- continuing one's own self development.

This represented a significant change in focus for school improvement policy to one that more directly supported teachers within the classroom and shifted the onus of accountability to the individual. For schools the rationale and incentive for teacher coaching was based on research that increasing teacher capacity had the most direct impact on improving student achievement (Hattie, 2003).

Coaching offers differentiation of professional learning for teachers within schools and recognises teachers are at different stages of their careers, and possessing varied levels of knowledge and skill. It successfully overcomes the difficulty of external professional learning transferring into their classroom. With many coaching models to choose from, the region I was working in adopted the Gradual Release of Responsibility framework. In this framework, the responsibility for the new learning in this case gradually shifts from the coach to the teacher who is being coached. This shift leads to the embedding and sustaining of change by the classroom teacher.

Teachers in primary schools require a deep understanding of mathematics for teaching and this is a key component in improving student learning outcomes (Hill, Rowan & Ball, 2005). My coaching has helped me to identify a common element that is fundamental for successful teaching in mathematics; teacher content knowledge, and the associated understanding of the continuum of learning that this provides. Where teacher content knowledge is poor, it stands to reason that so too is student learning. Developing both the practical and theoretical aspects through coaching leads to powerful gains for all stakeholders. It is widely accepted that teachers of mathematics require appropriate strength in both content and pedagogical content knowledge. In my role I am trying to address this issue by offering timely professional learning to teachers around a specific key mathematical idea. The purpose of these sessions is to give teachers some valuable kinaesthetic activities while building their own content knowledge and highlighting links to class management and organisation ideas.

Whilst initially many teachers viewed coaches suspiciously and as an inconvenience, this soon changed as they recognised the value to themselves and the children, and most schools across the region employed their own school-based coaches in both literacy and numeracy. My role as a regional coach became that of the main resource for the school based numeracy coaches. At the end of 2011 any lapsing government projects were not re-funded and unfortunately the coaching initiative was one of these. The network that I was working in had pooled their National Partnership Funding to support school improvement and to distribute resources. In 2012 the network funded me to continue the work as Network Numeracy Coach for the 22 schools within the network. As a result my role within the network allows teachers to work collaboratively and engage in reflective practices together. There has been a cultural change where professional learning is embedded into all schools I work with. The model I have developed within my network has been to divide school-based coaches into small working groups, who meet regularly to achieve a specific goal. As the network is extremely diverse (with P–9, primary, secondary and small rural schools) this model

allows me to meet the needs of all schools I am working with and supports a collective approach.

I am extremely passionate about my profession and everyday enjoy the challenges my job. Coaching has allowed me to focus on my greatest passion: the teaching of mathematics. I would not say that I am a great a mathematician (I am not) but I am a good coach. In my position I have the rare opportunity of going into a school and working closely with teachers and leadership teams. I am a critical observer who is not involved in the politics of the everyday running of the school and therefore can make suggestions. Building relationships is a crucial component of my work. Teaching is a very social occupation, interacting with students, parents, teachers and the wider community. Coaching can be an isolated position and for me the rewards come when I am working with a teacher who makes the ideas that I had shared with them previously their own. When they are so excited to see me the next time I am in their school to share something that worked well, that enthusiasm becomes infectious.

Implementing structured problem-solving mathematics lessons through Japanese lesson study

Lesson study is an ongoing, collaborative, professional development process that was developed in Japan. Teachers systematically examine their practice in order to become more effective instructors. The Trends in International Mathematics and Science Study (TIMSS) identified Lesson Study as a powerful, ongoing process for improving the quality of teaching in mathematics. (Stigler & Hiebert, 1999).

Lesson Study involves a number of steps.

- Teachers select a *research theme*.
  This theme focuses on a broad research question regarding their students that involves skills or attitudes they would like to foster.
- The research team selects a *goal and a unit of study* on which to focus.
  They research their students' abilities and needs within this unit of study. The team researches and shares 'best practice' ways to teach this.
- The team *creates the lesson*.
  Teachers select a lesson within the unit to develop, and follow an established lesson plan template. This template focuses on how the lesson fits within the broader school curriculum, linking the lesson topic and skills to previously learned content, and to content that will be learned in future grades. This lesson plan template also focuses on ways to assess student thinking during the lesson.
- The *lesson is taught* by a member of the group and observed by the other members, as well as other teachers in the school and usually some outsiders. The focus of the observation is on student thinking not on the teacher's abilities.
- The group then gets together to *discuss the lesson and their observations*.
  This is usually done on the same day. They evaluate the components of the lesson.
  - Who was the lesson just right for?
  - Who was too challenged?
  - Who was under challenged?
  - What would we do differently next time?
  - What are our next teaching steps for these students?

  Revisions are made to the lesson, based on these observations and analysis, and another member of the group may possibly be selected to teach the lesson again. This experience can lead to valuable insight into student thinking, strengths and weaknesses.
- At the end of this process, the group may produce a *report* that outlines what they learned in regards to their research theme and goal.

One of the fundamental elements of lesson study is that it is an ongoing process. The process focuses on the key actions of collaborating, planning, teaching, observing, reflecting and revising.

All lessons are informed by research and prereading. The team of teachers share the planning and responsibility of the lesson. The team matches the lesson to their students and agrees on roles for the lesson.

I was fortunate to be able to attend the IMPULS Lesson Study Immersion Program in Tokyo, Japan this year as a result of my involvement in the Deakin University *Implementing Structured Problem-solving Mathematics Lessons through Lesson Study* project over the past year. The professional learning of teachers is an ongoing process of knowledge building and skill development in effective teaching practice (NPEAT, 2003). This project became the vehicle to build teacher pedagogical content knowledge.

The collaboration between the schools and teachers involved, as well as the support from both our university colleagues at Deakin and the network, all resulted in teachers involved being more reflective of their practice. A highlight of the project was watching the confidence of the teachers in their teaching of mathematics build over the 12 months and being seen in their own schools as leaders of numeracy.

Influential programs

Numerous mathematics programs, texts and support materials emerge, seemingly constantly. One of the challenges faced by teachers is to select programs that will work successfully for their students and for themselves. I found two programs, *YuMi Deadly Maths* and *Back to Front Maths*, particularly useful for creating connections and encouraging genuine student dialogue.

YuMi Deadly Maths

In 2010 I was invited by the Sunshine/Deer Park Network to attend the YuMi Summit at Queensland University of Technology as a critical friend, to offer insights and help evaluate whether this project would be beneficial to the students in our schools. The summit was an opportunity for schools involved in the project to professionally engage, share and showcase their YuMi Deadly Maths experiences and journeys with colleagues.

'YuMi' is a Torres Strait Islander Creole word meaning "you and me" but is used with permission in this project to mean working together as a community for the betterment of education for all. "Deadly" is an Aboriginal word used to mean smart, in terms of being the best one can be in learning and life. (QUT 2010)

The YuMi Deadly Maths Program is based on two imperatives: first, that mathematics can empower all people's lives if understood as a conceptual structure, life-describing language and problem-solving tool; and second, that all people can excel in mathematics if taught kinaesthetically, contextually, with respect and with high expectations. It centres around a framework focussing on Reality, Abstraction, Mathematics, and Reflection (RAMR).

Reality

- Ensure existing knowledge prerequisite to the idea is known.
- Construct kinaesthetic activities that introduce the idea (and are relevant in terms of local experience).

Abstraction

- Develop a sequence of representational activities (physical-virtual-pictorial-language-symbols) that develop meaning for the mathematical idea.
- Develop two-way connections between reality, representational activities, and mental models through body hand mind activities.
- Allow opportunities to create own representations, including language and symbols.

Mathematics

- Enable students to appropriate and understand the formal language and symbols for the mathematical idea.
- Facilitate students' practice to become familiar with all aspects of the idea.
- Construct activities to connect the idea to other mathematical ideas.

Reflection

- Set problems that apply the idea back to reality.
- Lead discussion of the idea in terms of reality to enable students to validate and justify their own knowledge.
- Organise activities so that students can extend the idea (use reflective strategies—being flexible, generalising, reversing, and changing parameters).

The project has involved teachers in 12 schools in Victoria being trained using a 'train the trainer' and research-based models. My role has been to support trained teachers and facilitate a professional learning team with all trained teachers to continue the learning and ongoing implementation. In 2011, I accompanied teachers from six Victorian schools to the sharing summit in Brisbane. I was able to highlight the network approach to implementing the program into Victoria. In May this year I coordinated all schools in the project to showcase their learning and highlight best practice with delegates from schools not involved in the project at the Victorian sharing summit.

The YuMi Deadly Maths project identified key elements that I believe to be important to mathematics education. The train the trainer model and research-based professional learning supported the need to improve teacher pedagogical content knowledge. The ideas shared were kinaesthetic and engaging to both the teachers and students, but to me the 'aha' moment came when I saw children in Queensland doing the abstraction component of the RAMR framework. If an idea can be represented in a diagram, table or graph then it could be modelled kinaesthetically and then students make their own representation of where they were in the reality with symbols and language. In my experience of observing many schools across Victoria, the abstraction component was the missing link, what we were not doing. And yet it was so simple. For example, in a class we get students to use their bodies to get into 'groups of three or four' and discuss how many groups have been made. If we then do not get them to draw or represent what that looked like, we jump straight from the reality to the maths. We expect somehow as a child sits back at their table that they have made the link from the engaging 'groups of' activity to the multiplication worksheet in front of them.

Back to Front Maths

Last year I received a phone call from a numeracy coach I had met in Queensland telling me she had just attended an extremely valuable professional learning. With my passion for great maths teaching I was inspired to find out more and discovered *Back to Front Maths* (Kennedy, 2010). It is a problem-based teaching resource and contains a series of novel or unfamiliar problems that are used to introduce new topics, uncover student misconceptions, stimulate interest and experimentation and ultimately lead to building new mathematical understanding in students.

I am extremely fortunate that I get to observe numerous problem solving lessons in various settings. A constant issue during the lesson introduction is that the teacher tells the students how to get the answer and they lose the opportunity for students to develop their own capacity for logical reasoning and analytical thought. I try to highlight to teachers that I work with 'never tell a student something they can find out for themselves'. *Back to Front Maths* supports teachers to start asking students to solve a problem that they do not yet know how to solve. This requires the students to think mathematically, and experiment to try and work out a solution. Next, they look for student misconceptions (where the student has a fundamental misunderstanding of a concept), and help the students to analyse their ideas to see if they really work. When students self-correct their misconceptions, their mathematical understanding deepens and they learn concepts far more quickly (Kennedy, 2010).

Finally, and possibly most importantly, the teacher's primary role is one of asking really searching questions that encourage students to think deeply about a problem, access their prior knowledge about it, experiment with different ideas and then analyse how well these work when applied. Teachers help students to focus on the fundamental principles and patterns in mathematics, therefore enabling deep understanding and developing less need for repetition and memorisation.

As educators, "we understand something if we see how it is related or connected to other things we know." (Hiebert et al., 1997) Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are indeed reasonable. When students are told rather than being able to explore they tend to develop a fragmented set of rules and procedures that do not represent what the teacher intended (Williams, 2010).

At a facilitators training with Tierney Kennedy, the mastermind behind *Back to Front Maths*, I observed teachers having those 'aha' moments—calling in unison "we tell our students too much". The training is unique. Within the first hour of a two day training, teachers observe a *Back to Front* lesson in a classroom. By the completion of the lesson the observers have many insights into what these students know and do not know; the purpose of the problem-based task is to identify student misconceptions. The second day of training involves participants trialling a problem based lesson with students they have no prior knowledge of and in a school which is not their own. This form of professional learning gives participants a rare opportunity to trial their learnings and reflect on their own practice with the assistance of the facilitator and other participants.

Conclusion

Reflecting on this range of diverse and high quality projects has allowed me to isolate the key elements they have in common, to develop purposeful and genuinely effective maths teaching. The Gonski Review (Department of Education, Employment and Workplace Relations (DEEWR), 2012) highlights the need for extra specialist teachers in the area of literacy and numeracy, and a need to support teachers to sift through the numerous resources and projects available. I believe specialist coaching in mathematics is vital if we are to build teacher capacity. Lessons need to be engaging and challenging whilst making connections to prior concepts and student interests. I believe these projects have gained momentum because I was a network resource to coach and mentor teachers at the point of need to address issues and support trials.

As we launch to the future I can see the importance of not 'throwing out the old and in with the new'. As teachers begin to implement an Australian Curriculum, they should take with them best practice and keep borrowing and trialling those elements that engage our students, by making links to previous learning, other contexts and to experiences inside and outside the classroom. It is my belief that if we are to improve the quality of teaching and learning in mathematics, we need to be part of a community that shares ideas. Therefore we do not need to start from scratch ourselves but can learn from the teacher next door or the teacher on the other side of the world or the international guru. As Isaac Newton wrote (quoting an earlier scholar), "we can stand on the shoulders of giants".

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